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# COLLATERAL DAMAGE AND COMMUNICABLE DISEASE

With Particular Reference to Tactical Nuclear War in Europe

Harold H. Mitchell  
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31 October 1978

Topical Report for Period 1 October 1977—31 October 1978

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## PREFACE

A substantial effort has been expended in evaluating the collateral damage which might result if tactical nuclear weapons were used in the European Theater. These assessments have focused on the impact of prompt weapon effects (i.e., blast, thermal, and nuclear radiation) on the civilian population.

In addition to these prompt effects, however, nuclear weapons can disrupt the life support functions of the communities. Water and sewer lines can be broken, hospital facilities and drug supplies destroyed and food supplies diminished and possibly contaminated. A situation can easily be established in which major epidemics may spread through these disrupted areas causing widespread deaths.

An accurate assessment of the impact of these "secondary" effects is difficult (perhaps impossible) to make. However, experience from past wars can provide some guidance to estimate the potential consequences.

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## SECTION 1. INTRODUCTION

This paper reviews the historical incidences of major epidemics and attempts to assess the impact of wartime disruption on the frequency of disease outbreaks. Given the poor state of predictability of epidemiology for peacetime epidemics, what we really attempt here is a rendering of judgment based on:

1. The historical record (especially World War II experience).
2. The baseline statistics defining the communicable disease picture in Germany in recent years.
3. The knowledge now available to meet the expected problems.

It is correct to be concerned about the possible damage that might be done by communicable diseases, along with the other damaging modalities expected during a war. Communicable diseases, sui generis, have been responsible for the greatest disasters in history and as a secondary consequence of wartime disruption, they have usually been responsible for greater morbidity and mortality than physical-mechanical injuries.

Table 1 is an arbitrary selection of examples, arranged chronologically, of various epidemics [1]. When the world was ignorant of communicable disease causation, the classical scourges killed people in the millions (lack of personal and public hygiene, etc., also contributed mightily). One aspect of the table is

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<sup>1</sup> S. Garb and E. S. Garb, Disaster Handbook (2nd Edition), Springer Publishers, 1969.

Table 1. Examples of Epidemics - Worldwide

DATE	TYPE	PLACE	DEATHS	ESTIMATE OF POPULATION KILLED (PERCENT)
500-550	BUBONIC PLAGUE	EUROPE & ASIA	100,000,000	20-50
1348	BUBONIC PLAGUE	WORLD	25,000,000	25-75
1349-1350	BUBONIC PLAGUE	ENGLAND	1,200,000	20-30
1418	BUBONIC PLAGUE	PARIS	50,000	
1518	SWEATING SICKNESS	ENGLAND	MILLIONS	30-50
1520	SMALLPOX	MEXICO	MILLIONS	50
1603	BUBONIC PLAGUE	LONDON	34,000	14
1628	TYPHUS	LYONS, FRANCE	60,000	
1665	BUBONIC PLAGUE	LONDON	100,000	27
1711	BUBONIC PLAGUE	BRANDENBERG	215,000	
1722	BUBONIC PLAGUE	MARSEILLES	40,000	30
1831	CHOLERA	MOSCOW	4,500	
1875	MEASLES	FIJI ISLANDS	40,000	
1915	TYPHUS	SERBIA	150,000	
1918-1919	INFLUENZA	WORLDWIDE	20,000,000	
1920	DYSENTERY	POLAND	5,000	
1947	CHOLERA	EGYPT	11,000	
1966	MALARIA	BRAZIL	2,000	
1967	BUBONIC PLAGUE	NEPAL	17	
1968	BUBONIC PLAGUE	INDONESIA	40	
1968	CHOLERA	PAKISTAN	37	
1968	POLIO	TURKEY	98	

especially significant, and that is the later reported epidemics which show involvement of deaths below 100. The fact that these are worthy of being recorded as epidemics gives an indication of the startling changes which have taken place over historical time. Another item worthy of mention is the entry for 1918--the influenza pandemic which was responsible for 20,000,000 deaths world-wide--this disease is still a threat to the world. Influenza epidemics still occur with very high attack rates, but there has not been a repeat of the high death rates seen in 1918.

Wars have always brought increases in epidemic disease, both to the armies in the field and to the civilian populations involved in wartime disruptions. It is apparent from the historical record that most of the toll of communicable diseases during wartime occurred before the development of modern sanitation and bacteriology.

Germany, during the Thirty Years War (1618-1648), had severe epidemics of typhus fever and plague, and it has been estimated that the population fell from 16-17 million down to 4 million. This estimate has been challenged, and a 50 percent reduction in population was made as being more nearly the truth. Estimates of population loss for more localized regions are probably more accurate. For example, the population of Bohemia went from 3 million down to 780,000; Württemberg from 448,000 (1622) down to 97,000 (1648); Hesse sustained a loss of 25 percent of its population [2].

During the Napoleonic Wars, in the years 1813-1814, the German population was approximately 20,000,000 and the cases of typhus

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<sup>2</sup>F. Prinzing, Epidemics Resulting from Wars, Oxford Press, 1916.

fever amounted to approximately 2,000,000, with about 200,000 deaths. In the city of Berlin, with a population of 155,000 people, there were 1,184 deaths from typhus in 1813 (out of a total of 7,012 deaths) and 545 deaths from this disease in 1814 [2].

During the Franco-German War, there was an extensive smallpox epidemic. In all of Germany (population approximately 41 million), there were approximately 170,000 cases of smallpox in the years 1871-1872 [2].

Given the history of epidemic diseases, professionals in the fields of medicine and public health have registered surprise at the statistical description of Germany (and Japan) during World War II regarding communicable disease experience. Epidemic disease was much less of a problem than was anticipated. The absence of large-scale epidemics during the famine years in Greece (1941-1942) and the Netherlands (1941-1943) was also unexpected.

K. A. Western [3] has stated that "since the end of World War II, there has not been a single outbreak of the classical communicable diseases in Europe, Canada and the United States, which can be attributed to a disaster." Thus, it has been necessary to rely principally on the experience of World War II to provide the basic data for this study.

The use of the extensive data from World War II in Germany provides an important plus to this study. Epidemic disease

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<sup>3</sup>K. A. Western, "Epidemiology of Communicable Diseases in Disaster Situations (Summary)," Ann. Soc. Belge Med. Trop., Vol. 56, 1976, p. 199.

spread and control are highly dependent on the "social fabric" as it relates to personal hygiene, obeying of public health directives and countless other small but significant details. The closest we can come to assessing this aspect of the problem is to assume that Germany today is, in this regard, similar to the Germany of the 1940s.

The approach of this report, then, is to utilize the World War II experience as extensively as possible for bounding the problem of communicable disease occurrence. The current statistics on peacetime communicable disease incidence will be described, as this will be the "base line" for predicting the effects of future wartime disturbance.

The one qualitatively new feature which, except for Hiroshima and Nagasaki, was not present during World War II, is that of nuclear radiation. The effect of radiation exposure on communicable disease incidence will be addressed.

## SECTION 2. RECENT GERMAN COMMUNICABLE DISEASE STATISTICS [4-9]

It is important to have a firm description of the usual endemic-epidemic base for communicable diseases if one is to make judgments or predictions of the future course of these diseases under wartime conditions. The tables and figures presented in this section document that Germany is a remarkably "clean" country with regard to most communicable diseases. In the years just prior to 1973, the total number of reported contagious diseases has remained fairly constant, within a range of 70,000-80,000 per year (exclusive of tuberculosis and venereal disease).

Table 2 shows the disease incidence for several communicable diseases for the years 1967-1972. Notably absent from the record are the former scourges, such as cholera, smallpox, plague and typhus fever.

Scarlet fever, infectious hepatitis and salmonellosis are the diseases with the highest reported incidence and meningococcus meningitis and infectious meningitis are also diseases of relatively high prevalence.

In Table 3, a comparison is made (for the year 1973) between the U.S. and the Federal Republic of Germany for selected diseases as reported to the World Health Organization. It is apparent from the overall impression given by this chart that although there are differences between the two countries, Germany is quite adequately handling its communicable disease problems, if one uses the U.S. experience as a reference standard.

Table 4, which directs attention to the bacterial carrier problem, shows that there is a declining trend in the total



Table 2. Cases of Selected Contagious Diseases Subject to  
Compulsory Registration for West Germany

DISEASE	1967	1968	1969	1970	1971	1972
SALMONELLOSIS	8,240	6,926	6,257	12,410	10,817	13,842
INFECTIOUS ENCEPHALITIS	182	170	151	178	151	124
POLIOMYELITIS	54	59	25	15	17	15
PARATYPHOID FEVER	938	527	501	540	422	394
BACILLARY DYSENTERY	1,010	949	597	522	570	545
TYPHUS ABDOMINALIS	636	601	530	477	381	385
DIPHTHERIA	117	367	148	57	38	34
SCARLET FEVER	38,767	31,431	32,644	28,955	31,368	36,058
MENINGOCOCCUS MENINGITIS	1,331	1,065	1,185	1,800	1,638	1,577
INFECTIOUS MENINGITIS	7,859	3,900	3,938	4,987	4,609	4,940
INFECTIOUS HEPATITIS	21,328	20,938	21,216	21,770	22,738	23,321
AMEBIC DYSENTERY	60	17	49	20	28	48
TULAREMIA	8	7	3	1	2	1
ANTHRAX	8	3	4	2	6	3
WEIL'S DISEASE	53	27	18	19	26	33
Q FEVER	65	89	90	29	54	58
BRUCELLOSIS	66	59	57	65	93	107
MALARIA-NEW	49	54	61	55	88	109
MALARIA-RELAPSE	12	14	6	9	11	19

Table 3. Comparison of Disease Incidence: Federal Republic  
of Germany vs United States 1973 [9]  
(Population Ratio: US/West Germany = 3.5)

DISEASE	FED. REP. GER.	U.S.	DISEASE	FED. REP. GER.	U.S.
CHOLERA	6	1	CHICKEN POX	11 DEATHS	182,527 CASES 138 DEATHS
PARATYPHOID FEVERS	374	23,818	MEASLES	37 DEATHS	26,690 CASES 23 DEATHS
BACILLARY DYSENTERY	599	22,642	VIRAL ENCEPHALITIS	157	321 DEATHS
AMOEBIASIS	17	2,235	INFECTIOUS HEPATITIS	25,900	50,749
T.B. (RESPIRATORY)	29,536	27,051	MUMPS	6 DEATHS	69,612 CASES 12 DEATHS
T.B. (OTHER)	4,935	3,000+	PSITTACOSIS	135	33
TULAREMIA	3	171	TRACHOMA	9	26
ANTHRAX	3	2	TYPHUS, LOUSE-BORNE	1 DEATH	---
BRUCELLOSIS	108	202	Q FEVER	93	20
LEPROSY	6	146	MALARIA	137	237
DIPHTHERIA	37	228	SYPHILIS + SEQUELAE	5,847	87,469
WHOOPING COUGH	17	1,759	GONORRHEA	78,431	842,621
SCARLET F. + STREP TH.	43,724	474,212	LEPTOSPIROSIS	46	57
MENTINGOCOCCAL INF.	1,400	1,378	LEPTOSPIROSIS (ICT.)	23	?
POLIO - ACUTE	29	8	INFLUENZA - GRIPPE	1,955	5,131
POLIO - PARAL.	24	7	ENDEMIC TYPHUS		32
			ROCKY MT. SPOTTED FEVER		668
			RELAPSING FEVER - TICK BORNE		6

Table 4. Bacillus-Excreting Agents as per 31 December of Each Year for West Germany

LAND	ALL BACILLI CARRIERS							OF WHOM CARRYING BACILLI OF				
	1964	1965	1966	1967	1968	1969	1970	1971	ENTERITIS INFECTIONOSA (SALMONEL- LOSE)	PARA- TYPHOID A AND B	BACILLARY DYSENTERY	TYPHUS ABDO- MINALIS
SCHLESWIG-HOLSTEIN	1,125	1,098	1,003	975	937	872	822	786	17	338	2	429
HAMBURG	382	335	303	283	270	269	251	199	13	83	--	103
NIEDERSACHSEN	1,679	1,638	1,552	1,498	1,450	1,363	1,339	1,238	167	422	2	647
BREMEN	194	320	115	98	93	79	148	55	19	22	--	14
NORDRHEIN-WESTFALEN	2,864	2,655	2,494	2,360	2,217	2,134	1,983	1,943	263	764	1	915
HESSEN	419	419	381	345	408	365	363	371	72	131	15	153
RHEINLAND-PFALZ	446	436	410	397	443	374	368	281	28	136	--	117
BADEN-WÜRTTEMBERG	861	822	787	797	742	721	712	674	147	201	11	315
BAVARN	1,305	1,251	1,205	1,165	1,146	1,060	1,029	965	91	324	--	550
SAARLAND	232	225	239	246	232	190	203	216	62	113	--	41
BERLIN (WEST)	819	799	760	737	711	699	682	660	48	117	2	433
BUNDESGBIET	10,326	9,998	9,249	8,901	8,649	8,126	7,900	7,388	927	2,711	33	3,717

number of carriers from 10,326 in 1964 to 7,388 in 1971. It is known that Germany has had an elaborate system for monitoring and controlling its typhoid carriers since the end of World War II.

Figure 1 is an interesting graphic display of the trends of seven communicable diseases for the years 1948-72. There are dramatic falls shown for poliomyelitis and diphtheria (immunization programs) and a steady and significant downward trend for typhoid fever (carrier control program). Scarlet fever is still quite high and does not show a significant downward trend. The curves of infectious hepatitis, enteritis (mainly salmonellosis) and infectious meningitis are in uptrends.

It is worth noting that the mortality rate for contagious diseases (including tuberculosis and influenza) has reached a low figure of 15 deaths per 100,000 (1971).<sup>\*</sup> One-hundred years ago the rate was 2,500-3,000 per 100,000 and 20 years ago (1952) the rate was 45 per 100,000. Table 5 records the deaths for selected contagious diseases for the years 1967-1971.

---

<sup>\*</sup> The latest figures available to the author were in Statistical Atlas on Public Health in the Federal Republic of Germany, 1974. Although not much change is anticipated in the overall picture, more recent statistics should be obtained and monitored as an ongoing addendum to this report.

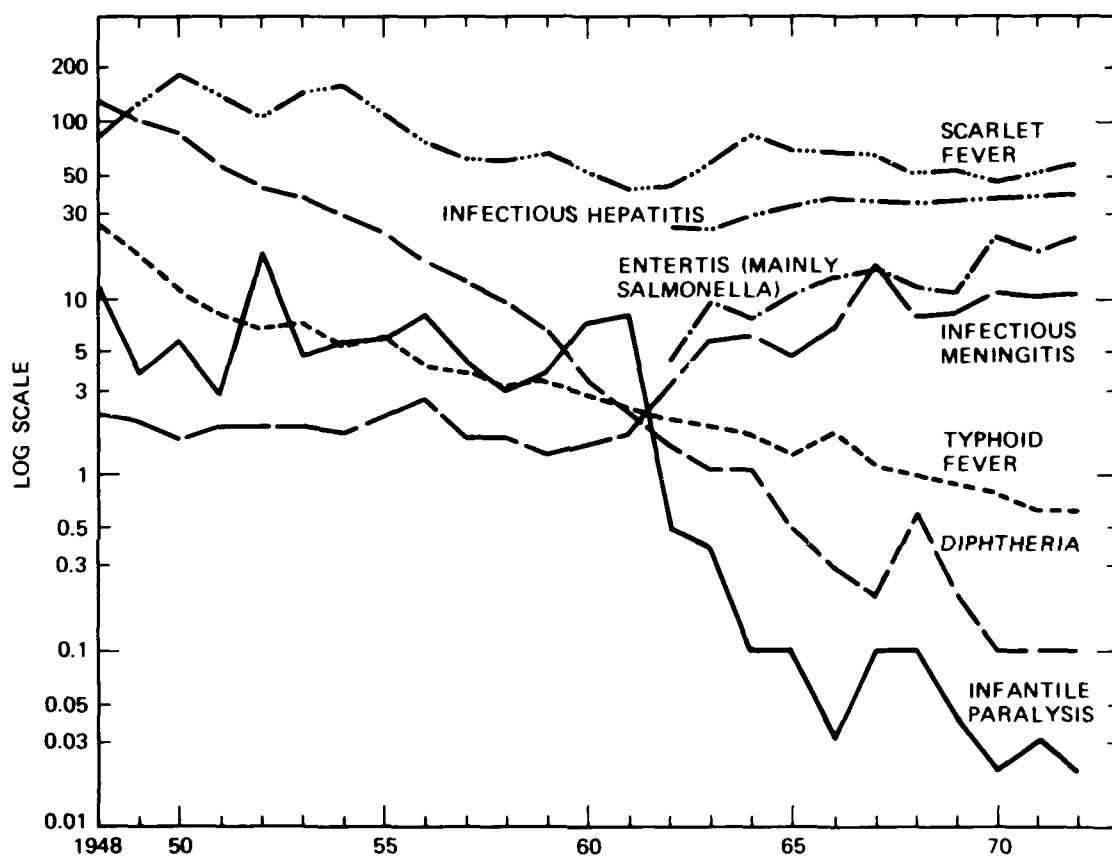


Figure 1. Development of Selected Contagious Diseases Subject to Compulsory Registration for West Germany, 1948-1972

Table 5. Deaths from Selected Contagious Diseases  
West Germany, 1967-1971

DISEASE	1967	1968	1969	1970	1971
TUBERCULOSIS	6,424	6,298	5,850	5,047	4,363
INFLUENZA	1,668	6,311	5,958	7,192	1,761
TYPHUS ABDOMINALIS	8	8	7	6	12
PARATYPHUS	14	6	6	8	9
OTHER SALMONELLA	25	20	17	39	31
DYSENTERY	3	4	4	4	6
SCARLET FEVER (+STREPT.)	1	9	12	9	9
DIPHTHERIA	4	5	4	3	5
MENINGOCOCCAL INFECTION	118	119	133	177	198
WHOOPING COUGH	41	37	46	35	24
TETANUS	84	102	84	82	64
WEIL'S DISEASE	9	7	5	1	6
POLIOMYELITIS	6	-	7	1	3
INFECTIOUS MENINGITIS	34	31	29	20	16
MEASLES	53	116	104	79	84
INFECTIOUS HEPATITIS	76	106	93	68	79
MALARIA	6	5	13	3	6

### SECTION 3. DISASTER EPIDEMIOLOGY

#### 3.1 THE U.S. STRATEGIC BOMBING SURVEY (U.S.S.B.S.) (GERMANY)

Following the end of World War II, a U.S. medical team attempted to assess the effect of aerial bombing of civilian population on the incidence and mortality of communicable diseases. This study [10] is an important source of data for assisting in making judgments on the current collateral damage issue.

As stated in the introductory remarks to the U.S.S.B.S. study:

Training, experience, and knowledge would lead one to expect a tremendous increase in communicable diseases to epidemiologic proportions when visualizing the destruction of German cities, but there were no major epidemics [10].

There were, of course, many epidemics during the years of the war, and an attempt was made to assess whether the bombing itself increased the incidence of the disease. The problem is complicated by the need to determine what effects should be attributable to the bombing. Besides the obvious one of destruction of property and the wounding and killing of people, there are the related ones of shelter living, nutritional status, availability and distribution of medical supplies, etc.

The study was mainly statistical, but the opinion of reliable German medical authorities was also sought. The diseases studied are shown in Table 6.

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<sup>10</sup>The United States Strategic Bombing Survey: The Effects of Bombing on Health and Medical Care in Germany, Medical Division, 1947.

Table 6. Diseases Included in U.S.S.B.S. Study

1. TYPHUS	8. EPIDEMIC MENINGITIS
2. DIPHTHERIA	9. INFLUENZA AND PNEUMONIA
3. SCARLET FEVER	10. TYPHOID FEVER
4. WHOOPING COUGH	11. PARATYPHOID FEVER
5. MEASLES	12. DYSENTERY
6. POLIOMYELITIS	13. BACTERIAL FOOD POISONING
7. EPIDEMIC ENCEPHALITIS	

### 3.1.1 Typhus Fever

Typhus fever is not endemic to Germany. It was most likely introduced by the immigration of foreign workers from eastern European countries where the disease was endemic. The labor camps provided living conditions conducive to the spread of typhus fever. Under pressure of wartime conditions, especially the bombing raids, the absolute separation of the native population from the foreign work force broke down, and typhus spread to the German civilians. As indicated in Table 7, there were no cases of typhus fever reported for the years 1938-1940 in the seven cities examined. In 1942, the case rate reached 0.23 (per 100,000) and climbed to 5.51 (per 100,000) in 1944.

The analysis of the typhus fever data for Magdeburg is particularly instructive (see Table 8). In 1943, no air raids were made on Magdeburg and only two cases of typhus appeared in the resident population, although this disease existed in considerable numbers in the foreign population. The bombing raids of 1944 seem to be associated with the epidemic which occurred among the German civilians.



Table 7. Annual Case Incidence of Typhus Fever in  
Seven German Cities in 1938, 1940, 1942-43-44  
(Rates per 100,000 Population; Annual Basis)

CITY	1938	1940	1942	1943	1944
Bochum	0.00	0.00	0.00	1.22	1.11
Duisburg	0.00	0.00	0.00	0.00	0.00
Frankfort	0.00	0.00	0.00	0.38	5.72
Hamburg	0.00	0.00	0.06	0.81	0.98
Kiel	0.00	0.00	0.00	0.35	0.00
Magdeburg	0.00	0.00	1.16	0.89	39.28
Nuremberg	0.00	0.00	1.08	0.58	7.76
Combined Cities	0.00	0.00	0.23	0.65	5.51

Table 8. Reported Cases of Typhus Fever in  
Magdeburg in 1943 and 1944

DATE		NUMBER OF CASES REPORTED AMONG	
YEAR	MONTH	RESIDENTS	DISPLACED PERSONS
1942	December	0	1
1943	January	0	5
	February	2	46
	March	0	43
	April	0	1
	October	0	0
1944	January	0	6
	February	0	37
	March	0	5
	April	8	19
	May	74	46
	June	4	12
	December	0	1

The survey concluded as follows:

In summary, it can be stated that although typhus fever did not assume epidemic proportions of any magnitude, a relationship between aerial bombings and outbreaks in German nationals cannot be disputed. The bombings led to an increased intermingling between Germans and foreigners by virtue of the fact that public shelters were shared by both groups alike and that evacuation could not be carried out separately for Germans and foreigners because of the disruption of transportation facilities. The decrease in cleanliness brought about by longer working hours and lack of soap must also be taken into account [10].

It is worth noting that the German authorities decided against an extensive mass immunization program against typhus. They felt that the basic cleanliness of the German population (absence of lice) was sufficient protection and that public health surveillance would control any outbreak.

### 3.1.2 Diphtheria

Interpreting the data on diphtheria in Table 9 is difficult because there was an epidemic in Germany in 1937-1938, which persisted and gave higher than usual rates into 1940.

The 1944 high rates are therefore even more significant since they are compared with years that were themselves above usual norms. The bombing data suggest that incidence of the disease rose after periods of heavy bombings. Some of the rise was considered to be part of the natural history of the disease, but all those concerned with the problem in Germany agreed that aerial bombing had an indirect effect on the incidence and course of the disease. (Table 10 shows the rise in mortality rates during the war years.)

Table 9. Annual Case Incidence of Diphtheria in  
Seven German Cities in 1938, 1940, 1942-43-44  
(Rates per 100,000 Population; Annual Basis)

CITY	1938	1940	1942	1943	1944
Bochum	503.18	571.90	303.91	281.79	363.70
Duisburg	399.08	290.39	297.40	225.87	379.19
Frankfort	128.00	315.09	143.71	158.29	202.82
Hamburg	201.25	253.33	246.98	272.85	341.91
Kiel	206.81	109.32	441.68	229.27	237.42
Magdeburg	363.05	309.00	397.00	363.05	425.48
Nuremberg	321.44	208.89	366.62	476.97	562.95
Combined Cities	263.00	281.01	280.70	277.15	351.05

Table 10. Diphtheria Mortality Rates

YEAR	PERCENTAGE
1938	4.5
1940	4.6
1942	4.8
1943	6.0
1944	7.1

The role which air warfare played in the morbidity and mortality of diphtheria was explained as follows:

By 1943, the German population was fatigued. The resistance of the people had been lowered owing to poor living conditions and to constant cuts in their food rations. They had become careless. Although a law had been passed early in the war providing that people ill with communicable diseases could go only to those bunkers and shelters which were designated for isolation, and if they were not near such a shelter or bunker they were to remain in their homes, the law was not always obeyed. For instance, a mother would not leave her sick child home and go to the bunker herself; she took the child along. Thus, children ill with diphtheria were taken to bunkers and shelters where they spread the disease, particularly to adults who had not been immunized and were thus vulnerable to it.

The changes in morbidity in diphtheria as compared with the picture of the disease as seen before the air war was started were:

1. A higher incidence among adults.
2. A more malignant and rapid course.
3. A mortality which averaged 4.5 percent for most of Germany, but in some places went up to 7 percent.
4. Multiple and serious sequelae such as myocardial damage, paralysis of the soft palate, and polyneuritides.

These polyneuritides were particularly resistant to therapy as were the other complications of diphtheria. Large doses of thiamin chloride were given without effect, and Professor Stepp of Munich, Germany's leading expert on vitamins and nutrition, stated in a personal interview that the whole subject of complications was conditioned by the poor nutritional state of the patients. He did not think the virulence of *Klebsiella diphtheriae* had changed, a belief which was borne out of bacteriologic studies.

Additional causative or contributory factors were thought to be:

1. That too many people who suffered from "sore throats" did not seek medical attention. First of all, they were hard pressed and rushed, doctors were busy, and transportation off schedule, and, second, absenteeism was blazoned by the press and all state and Nazi party agencies as unpatriotic--so too many "sore throats" were allowed to go untreated and to spread the pathogenic organism.
2. That compulsory immunizations caused an increased incidence in adults. Some public health men with somewhat old-fashioned conceptions of immunology (as Dr. W. Bolt of Cologne) claimed that many immunized children were carriers and infected nonimmunized adults. This was hotly debated by several well-qualified public health authorities. Thus, Dr. Hans Eller, public health officer of Augsburg, showed that in his city the increase of diphtheria was noticeable but by no means alarming, nor were there any complications such as observed in other cities. The reason for this was thought to be that compulsory immunization against diphtheria was started in 1935, and that, therefore, active immunity of a considerable degree had been produced in the population of Augsburg. The argument then, boils down to one conclusion: immunization was started too late in most German cities [10].

### 3.1.3 Scarlet Fever

There was an epidemic of scarlet fever in Germany in 1941, and a high incidence persisted into 1942 and 1943. The general conclusion was reached that no relation existed between bombing attacks and the incidence of scarlet fever. Nevertheless, some isolated instances suggested that air attacks did indeed raise the expected rates (see Table 11).

Table 11. Annual Case Incidence of Scarlet Fever in  
Seven German Cities in 1938, 1940, 1942-43-44  
(Rates per 100,000 Population; Annual Basis)

CITY	1938	1940	1942	1943
Bochum	230.25	403.33	586.97	437.92
Duisburg	278.58	286.22	692.34	482.60
Frankfort	160.36	187.72	542.74	581.28
Hamburg	188.27	263.14	719.42	446.36
Kiel	262.12	322.13	753.11	465.51
Magdeburg	192.79	241.05	715.01	618.22
Nuremberg	169.13	140.44	393.81	635.86
Combined Cities	200.65	256.00	652.92	505.31

In Munich, as a striking example, the number of reported cases before the air attacks averaged 20 a week. Since 1942, the weekly number of reported cases averaged 100. Reasons for this sharp rise were thought to be overcrowding in homes, at work, and in air raid shelters [10].

Table 12 showing combined-city mortality rates indicates that the war years yielded higher mortality rates, although this trend was downward from 1942-1944.

#### 3.1.4 Whooping Cough

The year 1940 was an epidemic year for whooping cough, yielding a high mortality rate as shown in Tables 13 and 14. The table also reveals increasing mortality rate trends for the years 1942-1944, although these years were all lower than the epidemic year of 1940.

Table 12. Annual Mortality Rates from Scarlet Fever  
(Combined Cities)  
(Rates per 100,000 Population; Annual Basis)

YEAR	PERCENTAGE
1938	1.73
1940	2.60
1942	9.08
1943	7.08
1944	5.94

Table 13. Annual Case Incidence of Whooping Cough in  
Seven German Cities in 1940, 1942-43-44  
(Rates per 100,000 Population; Annual Basis)

CITY	1940	1942	1943	1944
Bochum	244.45	128.99	93.37	25.98
Duisburg	451.80	127.38	246.75	164.01
Frankfort	446.42	177.81		66.14
Hamburg	321.97	127.89	145.59	182.99
Kiel	693.46	195.03	366.20	170.59
Magdeburg		344.44	308.52	124.46
Nuremberg	321.65	138.09	168.22	109.41
Combined Cities	377.40	159.87	193.61	140.95

Table 14. Annual Mortality from Whooping Cough  
(Combined Cities)  
(Rates per 100,000 Population; Annual Basis)

YEAR	PERCENTAGE
1938	3.51
1940	5.90
1942	2.50
1943	4.18
1944	4.27

The reason for this increase in mortality was thought to be the frequent disorganization of home and hospital life, the disruption of heating facilities, and other factors resulting from aerial warfare. The infants and small children had to be moved from the wards to shelters or bunkers as often as two or three times daily, which practice led to an increase in the duration of the disease and in its complications [10].

There is no indication of a relationship between the actual intensity of the air attacks and the level of whooping cough.

#### 3.1.5 Measles

The incidence of measles did not change much in Germany during the war years, as shown in Table 15. Sporadic outbreaks, apparently unrelated to bombings, occurred in several cities. The year 1944 showed a high mortality rate largely due to the increased deaths in epidemics in two cities (Bremen and Dusseldorf).



Table 15. Annual Mortality from Measles in  
Thirteen German Cities in 1938, 1940, 1942-43-44  
(Rates per 100,000 Population; Annual Basis)

CITY	1938	1940	1942	1943	1944
Augsburg	3.28	1.09	4.81	1.08	0.00(10)
Bochum	1.27	4.20	2.28	0.82	0.66(10)
Bremen	0.86	2.54	1.39	5.09	9.82(10)
Cologne	3.52	2.22	1.38	0.43(5)	2.59(8)
Dortmund	0.75	0.94	1.72	2.65	0.80(9)
Duisburg	2.75	3.47	4.00	3.53	3.06(10)
Duesseldorf	3.55	3.31	2.90	1.34(9)	6.00(7)
Hamburg	0.48	0.71	1.31	1.48	0.82(10)
Kiel	0.40	0.36	0.35	0.35	2.61(10)
Magdeburg	1.83	0.88	1.45	1.48	1.04(10)
Mulheim	2.22	1.44	3.73	3.33	0.00(10)
Nuremberg	2.40	0.50	2.42	2.62	0.84(10)
Solingen	0.00	0.00	1.62	1.72	3.22(10)
COMBINED CITIES	1.70	1.63	1.91	1.82	2.46(10)

#### 3.1.6 Poliomyelitis

1938 was an epidemic year for poliomyelitis in Germany, and rates were higher on the whole for that year than any of the subsequent war years (see Table 16). No correlation is claimed between increased incidence of the disease and air attacks.

#### 3.1.7 Epidemic Encephalitis

The incidence of epidemic encephalitis, although lowest in 1938, did not increase excessively during the years 1942-1945 over the incidence for the year 1940 (see Table 16). No relationship was found between incidence of the disease and bombing intensity.

#### 3.1.8 Epidemic Meningitis

1939-1941 were epidemic years for epidemic meningitis. This accounts for the high incidence rates for 1940 (see Table 16). The incidence rates for the years 1942-1944 are within normal limits in comparison with the year 1938.

German physicians and public health officers stated that the incidence and mortality of the disease did not change during the years of bombing. This result could be considered unexpected in view of the changed conditions of life regarding crowding and shelter occupancy.

#### 3.1.9 Influenza and Pneumonia

As shown in Table 17, the mortality from influenza and pneumonia was low during the years of bombing. Only the city of Duisburg showed a significantly high rate in 1944, but its rate in 1938 was also high. Careful analysis of the bombing data seemed to

Table 16. Annual Case Incidence of  
Polio myelitis, Epidemic Meningitis, and Epidemic Encephalitis  
in Seven German Cities in 1938, 1940, 1942-43-44  
(Rates per 100,000 Population; Annual Basis)

CITY	POLIO MYELITIS					EPIDEMIC ENCEPHALITIS					EPIDEMIC MENINGITIS				
	1938	1940	1942	1943	1944	1938	1940	1942	1943	1944	1938	1940	1942	1943	1944
BOCHUM	1.91	0.00	0.98	0.41	1.11	0.32	0.65	1.95	0.00	0.00	3.50	6.78	2.28	3.67	2.76
DUISBURG	4.35	0.00	0.53	1.93	1.50	0.23	0.93	0.00	0.32	0.00	4.35	9.73	2.66	2.89	2.26
FRANKFURT	27.09	1.62	5.29	1.90	1.27	0.36	0.18	0.00	0.19	0.00	0.91	5.40	2.19	3.23	2.23
HAMBURG	3.45	2.24	7.43	2.22	2.65	0.18	0.35	0.24	0.67	0.69	2.08	8.33	3.57	2.48	3.63
KIEL	1.20	10.20	0.35	3.14	1.48						0.80	0.73	0.00	1.39	1.48
MAGDENBURG	0.91	0.29	1.16	1.19	0.44	0.30	0.00	0.00	0.00	0.00	4.26	8.49	3.49	4.45	2.81
MUEPBERG	12.25	3.27	2.15	1.46	11.29	0.00	0.00	0.54	0.87	0.71	6.97	4.03	5.92	3.50	2.21
COMBINED CITIES	7.27	2.22	4.39	1.92	2.89	0.21	0.35	0.33	0.46	0.39	2.89	7.02	3.14	2.91	2.82

Table 17. Annual Mortality from Influenza and Pneumonia in  
Thirteen German Cities in 1938, 1940, 1942-43-44  
(Rates per 100,000 Population; Annual Basis)

CITY	1930	1940	1942	1943	1944
AUGSBURG	60.17	70.52	65.69	69.76	79.61
BOCHUM	116.56	93.65	99.02	75.03	110.30
BREMEN	56.49	64.99	53.33	74.27	101.15
COLOGNE	80.89	115.84	97.78	115.22(5)	84.63
DORTMUND	109.19	99.12	97.32	97.51	111.61
DUISBURG	147.77	118.57	124.98	125.62	167.62
DUESSELDORF	100.31	134.66	95.19	98.96(9)	86.51
HAMBURG	84.31	126.46	104.29	95.78	81.78
KIEL	68.14	127.54	50.23	55.40	71.41
MAGDEBURG	85.28	68.83	72.60	73.20	81.43
MULHEIM	124.06	105.35	118.66	107.35	112.64
NUREMBERG	82.40	108.98	89.37	88.05	74.79
SOLINGEN	121.20	123.00	90.81	65.47	74.13
COMBINED CITIES	92.38	110.53	92.99	92.11	92.91

confirm that, even with the low rates, some of the mortality figures were correlated with the increases in bombing attacks.

#### 3.1.10 Gastrointestinal Disease

The group of gastrointestinal diseases (typhoid fever, paratyphoid fever, dysentery, bacterial food poisoning) showed no rise, but, in fact, fell during the years of aerial warfare, as indicated in Table 18. Some individual cities showed increases at various times, but there was no trend for the group as a whole.

#### 3.1.11 Typhoid Fever

No significant increase in typhoid fever was noted during the war years, as indicated in Table 19. Sporadic outbreaks were usually traced to foreign laborers who had contaminated a water supply.

The German public health system had an effective "typhoid carrier" control program, which undoubtedly contributed to the control of spread of this disease.

#### 3.1.12 Paratyphoid Fever

A modest increase in paratyphoid fever was observed during the years 1942 and 1943, as shown in Table 20, which may be correlated with increased air attacks. Sporadic outbreaks of this disease were also attributed to contamination of some water supply by foreign workers.

Table 18. Annual Case Incidence of Gastrointestinal Disease in  
Six German Cities in 1938, 1940, 1942-43-44  
(Rates per 100,000 Population; Annual Basis)

CITY	1938	1940	1942	1943	1944
Bochum	15.93	16.46	14.00	51.38	23.21
Duisburg	21.31	26.87	81.27	64.57	37.24
Frankfort	19.45	21.08	18.05	21.85	5.09
Hamburg	29.66	44.77	35.62	25.10	17.17
Magdeburg	10.67	30.76	51.99	24.30	26.92
Nuremberg	15.86	34.74	26.38	25.37	34.23
Combined Cities	23.17	35.75	36.28	30.78	21.30

Table 19. Annual Case Incidence of Typhoid Fever in  
Seven German Cities in 1938, 1940, 1942-43-44  
(Rates per 100,000 Population; Annual Basis)

CITY	1938	1940	1942	1943	1944
Bochum	3.82	4.84	4.23	14.68	10.50
Duisburg	4.58	2.78	3.46	10.60	1.50
Frankfort	3.27	0.72	7.66	1.71	1.59
Hamburg	3.10	1.24	2.26	2.75	3.43
Kiel	9.22	20.41	1.39	10.45	2.95
Magdeburg	2.44	1.76	4.07	2.37	5.74
Nuremberg	1.20	0.76	5.11	3.50	4.94
Combined Cities	3.47	2.92	3.65	4.77	3.83

Table 20. Annual Case Incidence of Paratyphoid Fever in  
Six German Cities in 1938, 1940, 1942-43-44  
(Rates per 100,000 Population; Annual Basis)

CITY	1938	1940	1942	1943	1944
Bochum	4.14	3.55	2.28	28.54	5.53
Duisburg	2.29	3.01	24.78	4.82	0.38
Frankfort	3.45	1.62	2.19	7.03	0.32
Hamburg	5.06	4.84	6.96	4.63	3.24
Madgeburg	1.22	1.76	2.03	1.78	1.32
Nuremberg	9.37	4.03	0.27	0.29	7.06
Combined Cities	4.56	3.67	6.53	6.09	2.97

### 3.1.13 Bacillary Dysentery

Bacillary dysentery was a common and fairly mild disease with no deaths. As shown in Table 21, significant increases were noted in World War II, presumably due to the decrease in sanitation.

### 3.1.14 Bacterial Food Poisoning

There was no overall increase in the incidence of this disease during the war years 1942-1945, as shown in Table 22. No correlation of cases with bombings could be established.

In summary, gastrointestinal diseases as a group did not appear to increase significantly in incidence as a result of the bombing of German cities. Some sporadic outbreaks did occur but without definite attribution to bombing damage.

Table 21. Annual Case Incidence of Dysentery in  
Six German Cities in 1938, 1940, 1942-43-44  
(Rates per 100,000 Population; Annual Basis)

CITY	1938	1940	1942	1943	1944
Bochum	5.10	8.07	7.49	7.75	6.63
Duisburg	5.73	12.74	50.37	38.23	32.73
Frankfort	12.73	12.43	5.65	13.11	2.54
Hamburg	20.96	37.80	25.98	17.32	9.32
Magdeburg	4.57	25.48	45.89	20.15	19.80
Nuremberg	5.29	29.19	19.92	19.83	16.94
Combined Cities	13.42	26.61	25.14	18.48	12.88

Table 22. Annual Case Incidence of Bacterial Food Poisoning in  
Six German Cities in 1938, 1940, 1942-43-44  
(Rates per 100,000 Population; Annual Basis)

CITY	1938	1940	1942	1943	1944
Bochum	2.87	0.00	0.00	0.41	0.55
Duisburg	8.71	8.34	2.66	10.92	2.63
Frankfort	0.00	6.31	2.55	0.00	0.64
Hamburg	0.54	0.89	0.42	0.40	1.18
Magdeburg	2.44	1.76	0.00	0.00	0.00
Nuremberg	0.00	0.76	1.08	1.75	5.29
Combined Cities	1.72	2.55	0.96	1.44	1.62



### 3.1.15 Summary of U.S.S.B.S. Study

Table 23 represents an overall summary of the U.S.S.B.S. study. The combined statistics show that there were no devastating epidemics and also no universal trend in all diseases toward greater increase, as the war progressed. Some diseases in 1944 had greater and some lesser incidence than in the prewar years of 1938. Also, the year of highest incidence varied for each disease. The impression is one of an increased overall incidence during the war years, with the numerical results dominated by the large relative incidence of diphtheria, scarlet fever and whooping cough.

Approximately the same impression is given by Table 24, which summarizes the mortality rates for five diseases. The war years showed moderately higher rates for the war years without any actual trend toward increase as the war progressed.

Table 25 summarizes the highest mortality rate recorded for each disease by city and year. This attempts to show the limits of severity encountered in specific locations without the diluting effect of averaging for all the population involved in the study. As expected, diphtheria, scarlet fever and whooping cough are dominant with influenza-pneumonia and combined gastrointestinal disease following with considerably lower rates.

Comparing the highest rate recorded with the average combined cities' rate for prewar 1938, one can see the factor increases involved. The rarer diseases tend to show greater values (from "infinity" for typhus because of zero incidence in 1938 and 9.3 for epidemic encephalitis down to 1.8 for influenza-pneumonia).

Table 23. Effects on Bombing on Infectious Disease  
Incidence in Germany, WWII

DISEASE	NUMBER OF CITIES	ANNUAL CASE INCIDENCE RATE (PER 100,000 POPULATION)				
		1938	1940	1942	1943	1944
TYPHUS FEVER	7	0.00	0.00	0.23	0.65	5.51
DIPHTHERIA	7	263.00	281.01	280.70	277.15	351.05
SCARLET FEVER	7	200.65	256.00	652.92	505.31	341.64
WHOOPING COUGH	7		377.40	159.87	193.61	140.95
POLIOMYELITIS	7	7.27	2.22	4.39	1.92	2.89
EPIDEMIC MENINGITIS	7	0.21	0.35	0.33	0.46	0.39
EPIDEMIC ENCEPH.	7	2.89	7.02	3.14	2.91	2.82
GASTROINTESTINAL DIS.	6	23.17	35.75	36.28	30.78	21.30
COMBINED AVERAGE		71.27	119.97	142.23	126.60	108.32

Table 24. Effects of Bombing on Infectious Disease  
Mortality in Germany, WWII

DISEASE	NUMBER OF CITIES	ANNUAL MORTALITY RATE (PER 100,000 POPULATION)				
		1938	1940	1942	1943	1944
DIPHTHERIA	13	11.74	12.80	13.36	16.70	25.02
SCARLET FEVER	13	1.73	2.60	9.08	7.08	5.94
WHOOPING COUGH	13	3.51	5.80	2.50	4.18	4.27
MEASLES	13	1.70	1.63	1.91	1.82	2.46
INFLUENZA + PNEUMONIA	13	92.38	110.53	92.99	92.11	92.91
COMBINED AVERAGE		22.21	26.67	23.96	24.38	26.12

Table 25. Summary of Highest Morbidity Rates Recorded  
(Rates per 100,000 Population; Annual Basis)

DISEASE	HIGHEST RATE RECORDED RATE YEAR	CITY	LOWEST RATE FOR INDICATED CITY RATE YEAR	COMBINED CITIES RATE 1938 (AVERAGE)	RATIO HIGHEST (AVERAGE)	REMARKS
Typhus	39.28 1944	Magdenburg	0.00 1938	0.00	0.00	
Diphtheria	562.25 1944	Nuremberg	208.89 1940	263.00	2.1	
Scarlet Fever	753.11 1942	Kiel	262.12 1938	200.65	3.7	
Whooping Cough	693.46 1940	Kiel	170.59 1944		4.9	No Data for 1938 (140.45 Rate for 1944)
Measles (Mortality)	9.82 1944	Bremen	0.86 1938	1.70	5.9	
Polio-myelitis	27.09 1938	Frankfort	1.27 1944	7.27	3.7	1938 was Highest Rate Recorded for Combined Cities--1943 was lowest
Epidemic Meningitis	1.95 1942	Rochum	0.00 1943-44	0.21	9.3	
Epidemic Encephalitis	9.73 1940	Duisburg	2.26 1944	2.89	3.4	
Influenza and Pneumonia (Mortality)	167.62 1944	Duisburg	118.57 1940	92.38	1.8	
Typhoid Fever	20.41 1940	Kiel	1.39 1942	3.47	5.9	
Paratyphoid Fever	28.54 1943	Bochum	2.28 1942	4.56	6.3	
Dysentery	50.37 1942	Duisburg	5.73 1938	13.42	3.6	
Bacterial Food Poisoning	10.92 1943	Duisburg	2.63 1944	1.72	6.3	
Combined Gastro- intestinal Disease	81.27 1942	Duisburg	21.31 1938	23.17	3.5	Summation of the 4 Diseases Immediately Above

The 2.14, 3.75 and 4.93 factor increases for diphtheria, scarlet fever and whooping cough are of interest because of the high basic rates from which they escalate. With regard to the influenza-pneumonia figures, it should be noted that this is a mortality rate; nevertheless, the increase of the rate by a factor of 1.8 is significant as this is a disease classification of high incidence.

The increased factor of 3.5 for "combined" gastrointestinal disease is worthy of comment. One would have expected this, a priori, to have been much higher given the amount of disruption of sewage and water supply systems and the envisioned lowering of sanitation standards in the handling of food under wartime conditions.

### 3.2 THE LEAGUE OF NATIONS SURVEY

The following observations have been taken from the League of Nations Survey [11].

For most contagious diseases, an increase in the number of cases notified began from the time of the prewar mobilization and has definitely expanded since the outbreak of hostilities. This is particularly the case as regards scarlet fever and diphtheria, for which record figures were notified in 1942 and 1943 [see Table 26].

The increase in the number of cases of meningitis preceded the war and after 1940 an improvement as regards the epidemic outbreak was observed.

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<sup>11</sup>Y. M. Briand, Health in Europe--A Survey of the Epidemic and Nutritional Situation, Bulletin of the Health Organization, League of Nations, Vol. 10, No. 4, 1943-1944.

Typhoid and paratyphoid fevers showed an appreciable rise from 1942. Dysentery, already abnormally high before the war, remained high during the war. German civilians showed an increase only in the mild form of dysentery caused by Sonne bacillus.

The increase in endemic contagious diseases is primarily due to mixing of the population and the increase in communal living brought on by wartime changes.

The arrival of persons from rural areas and also from the countries of Central Europe into the industrial centers is another principal cause for the increase in some contagious diseases (especially typhus fever). Typhus fever spread was limited because of the small numbers of body lice existing in the German civilian population.

From the figures and indications available, it appears that, on the whole, the health situation in Germany is favorable; that though extensive movements of the population have provoked an increase in common contagious diseases, this is a temporary phenomenon, unaccompanied by any serious increase in fatality from those diseases.

Although no statistics are available on the 12 million or so foreigners (prisoners and civilians), their health situation is reported to be very bad (a reflection on their bad housing and sanitary conditions, etc.).

As shown in Table 26, the composite epidemic index rose from a base standard of 100 (1928-1938 median) to a high of 295.7 by 1942.

Using 1937-38 as a base (approximately 140), the epidemic index went up by somewhat more than a factor of two (to 295.7) by 1942. It fell back to 253.9 in 1943.

Table 26. Communicable Diseases: Cases Notified in Germany (Altreich)

DISEASE	MEDIAN 1928-1938	1937	1938	1939	1940	1941	1942	1943
TYPHOID FEVER	3,051(s)	3,051	2,941	2,679	3,046	2,055	4,885	6,861
PARATYPHOID FEVERS	2,725(s)	3,755	3,211	2,434	2,930	3,735	5,102	3,666
DYSENTERY	3,472	7,515	5,191	6,135	12,705	8,731	12,112	5,183
DIPHTHERIA	76,877	135,446	149,490	143,585	138,397	173,161	237,047	238,109
SCARLET FEVER	111,545	117,400	114,219	129,791	136,567	251,969	325,206	248,678
CER-SP. MENINGITIS	962	1,532	1,916	5,113	3,210	3,218	1,877	1,761
POLIOMYELITIS	1,710	2,737	5,717	3,740	1,531	4,076	3,411	2,450
TYPHUS FEVER	1	-	-	-	6	395	2,100	1,668(r)
SMALLPOX	-	-	-	-	-	-	1	1
NOTIFIED CASES	200,343	281,546	282,585	293,270	300,588	417,073	592,361	508,077
COMPOSITE EPIDEMIC INDEX	100	140.5	141.11	146.4	150.0	223.6	295.7	259.9

### 3.3 THE GREEK EXPERIENCE OF 1941-1942

The following paragraphs have been excerpted from Reference 12:

World War II caused severe dislocations in Greece with a country-wide famine, during the years 1941-1942. Overall statistics for the country are not available but the Athens-Piraeus (population 956,813 in 1940 census) area has been reported on.

The Greek experience, consisting of a famine whose acute effects lasted two years (May 1941-April 1943) in a war-involved country, was not accompanied by any severe epidemic disease increase.

During the famine years, there was a marked increase in 'violent deaths' which includes deaths due to famine (see Figure 2). The senility deaths also were augmented by a famine component. The figure also indicates a rise in deaths due to infectious disease but this was obviously moderate.

Table 27 data indicate that the infectious disease deaths increased but that there were no large scale epidemics. There was one small epidemic of typhus and one of malaria in 1942. Tuberculosis death rates also rose considerably in 1942, as did typhoid fever.

### 3.4 NETHERLANDS OCCUPATION, WORLD WAR II

The following paragraphs have been excerpted from Reference 13:

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<sup>12</sup>V. G. Valaoras, "Some Effects on Famine on the Population of Greece," The Milbrook Memorial Fund Quarterly, Vol. 24, 1946, p. 215.

<sup>13</sup>G. H. Bourne, Starvation in Europe, G. Allen and Unwin, Ltd., London, 1943.



VIOLENT DEATHS INCLUDE FAMINE DEATHS, AND SENILITY DEATHS  
ARE UNDOUBTEDLY AUGMENTED BY A FAMINE COMPONENT

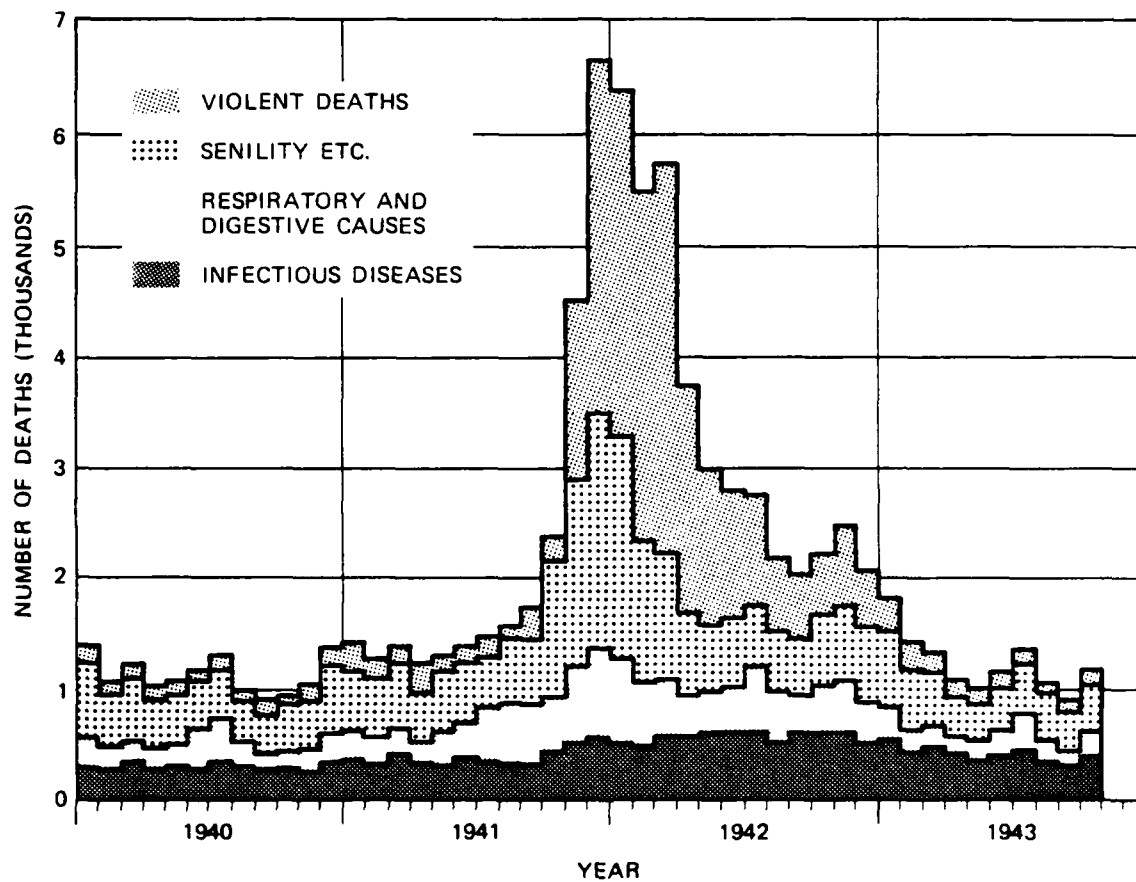


Figure 2. Numbers of Deaths by Broad Groups of Causes in Athens and Piraeus, 1940-1943

Table 27. Numbers of Deaths in Athens and Piraeus of Both Sexes by Cause

CAUSE	MONTH AND YEAR (BY HALF-YEARS)											
	1940		1941		1942		1943 <sup>2</sup>		1944 <sup>2</sup>			
	JAN.- JUNE	JULY- DEC.	JAN.- JUNE	JULY- DEC.	JAN.- JUNE	JULY- DEC.	JAN.- JUNE	JULY- DEC.	JAN.- JUNE	JULY- DEC.	JAN.- FEB.	
INFECTIOUS AND PARASITIC DISEASES	1,764	1,721	2,009	2,409	3,205	3,313	1,805	1,429	1,805	1,429	524	
TYPHOID	12	59	38	60	26	81	16	59	16	59	4	
TYPHUS	---	---	---	---	42	11	---	---	---	---	---	
MALARIA	2	23	13	20	7	205	11	15	11	15	1	
TUBERCULOSIS	1,287	1,244	1,498	1,820	2,583	2,425	1,468	1,105	1,468	1,105	389	
RESPIRATORY SYSTEM	997	622	910	1,226	1,681	862	486	288	486	288	253	
DIGESTIVE SYSTEM	580	892	756	2,240	1,425	1,966	294	578	294	578	89	
CIRCULATORY SYSTEM	799	614	822	1,612	1,463	834	599	397	599	397	245	
NERVOUS SYSTEM	683	568	720	958	848	548	306	284	306	284	125	
GENITO-URINARY	434	391	438	964	868	604	268	215	268	215	76	
CANCER	490	500	424	540	359	359	243	348	243	348	89	
SENILITY	350	288	460	1,771	2,178	963	401	226	401	226	112	
VIOLENT DEATHS	135	201	632	4,884	13,847	3,859	506	586	506	586	372	
ILL-DEFINED	240	243	347	1,053	624	279	204	102	204	102	62	
TOTAL DEATHS <sup>1</sup>	6,880	6,468	7,916	18,280	26,924	13,887	5,330 <sup>2</sup>	4,649 <sup>2</sup>	5,330 <sup>2</sup>	4,649 <sup>2</sup>	2,057 <sup>2</sup>	

<sup>1</sup>Deaths from rheumatism and some other diseases are not given in this table but are included in the totals.

<sup>2</sup>Deaths in 1943 and 1944 are for only 72 percent of the total population of Athens and Piraeus.

The combination of deficient diet, along with the numerous other hardships of the occupation, was responsible for an overall increase in the death rate in 1941 as shown in Table 28. Morbidity and mortality rates from communicable disease also rose during the war (Netherlands had the lowest prewar rates in Europe).

Table 28. Netherlands  
Increase of the Death-Rate in 1941  
(As Percentage of 1939)  
(Exclusive of Direct War Casualties)

Children Under 4	31 Percent
Children 5-14	27 Percent
Adolescents	43 Percent
Adults	14 Percent

Table 29 shows the number of cases reported for the years through 1943, for nine diseases. Using the 1928-38 median number of notified cases to equal 100, a composite epidemic index is calculated which shows a rise to 565.6 for 1943 from a 75.7 low in 1937. The total number of cases reported in 1937 was 12,527 and this rose to 93,548 by 1943.

Using 1939 as an index year, the morbidity rates for seven contagious diseases are compared for the years 1940-42 in Table 30. There is a ten-fold rise in diphtheria which probably has to be at least partially explained by an interruption in usual immunization programs. The six-fold increase in dysentery is also significant.

Looking at death rates (Table 31), there was an approximate doubling (1941 over 1939) for influenza and for 'contagious diseases' (exclusive of influenza and tuberculosis). Deaths from diarrhea and enteritis increased by 54 percent.

By modern standards, the rise in the morbidity and the mortality of contagious diseases was considerable. Nevertheless, there were no devastating epidemics during the war years in the Netherlands, even for the year 1944 which was even more stressful than any of the years through 1943.

Table 29. Communicable Diseases: Cases Notified in the Netherlands

	MEDIAN 1928-1938	1937	1938	1939	1940	1941	1942	1943
TYPHOID FEVER	359 ( )	237	201	172	108	167	526	534
PARATYPHOID FEVER	258 ( )	523	206	286	266	310	305	345
DYSENTERY	390	425	1,019	712	1,193	3,128	1,119	5,360
DIPHTHERIA	1,251	1,073	1,273	1,273	1,730	5,501	19,527	56,603
SCARLET FEVER	11,004	10,109	11,555	10,257	8,811	7,198	12,691	28,576
CER-SP. MENINGITIS	129	90	129	150	277	448	198	160
POLLIO MYELITIS	148	60	691	403	111	452	193	1,966
TYPHUS FEVER	0	1	-	-	-	-	-	1
SMALL POX	0	-	-	-	-	-	-	-
NOTIFIED CASES	16,559	12,527	15,077	13,253	12,526	17,501	37,567	93,548
COMPOSITE EPIDEMIC INDEX	100	75.7	91.2	80.1	75.6	105.9	227.1	565.6

Table 30. Netherlands  
Increase in Certain Contagious  
Diseases Since 1939 (Index Figures)

DISEASE	1939	1940	1941	1942 (FIRST 4 MONTHS ONLY)
Scarlet Fever	100	84	70	83
Diphtheria	100	136	430	1,170
Dysentery	100	170	480	653
Typhoid Fever	100	80	94	225
Paratyphoid Fever				
Poliomyelitis	100	28	101	330
Cerebrospinal Meningitis	100	184	222	82

Table 31. Netherlands  
Increasing Number of Deaths According  
to Different Causes (in Index Figures)

DISEASE	1939	1941
1. Influenza	100	224
2. Tuberculosis	100	147
3. Bronchitis	100	136
4. Pneumonia	100	120
5. Contagious Diseases (except 1 and 2)	100	198
6. Diseases of the Respiratory Tract (Except 4)	100	136
7. Diarrhea and Enteritis	100	154
8. All Other Diseases	100	104

### 3.5 U.S. STRATEGIC BOMBING SURVEY--JAPAN

The following paragraphs have been excerpted from Reference 14:

This survey of the effects of bombings on communicable diseases in Japan was done in a similar manner to the German survey. Six cities were included in the survey, including Kyoto which was not bombed and, therefore, represented a 'control' city for estimating bombing effects. The communicable diseases included in the survey are listed in Table 32.

Table 32. Communicable Diseases Included in This Survey

1. Dysentery	5. Typhus Fever
2. Typhoid Fever	6. Scarlet Fever
3. Paratyphoid Fever	7. Diphtheria
4. Smallpox	8. Meningococcus Meningitis

Although it does not appear useful to report this study in detail, several observations made in the report are worth noting:

An outstanding incidence of dysentery occurred in Nagoya in 1945. Extensive bombing in May and June preceded the outbreak which began in July, peaked in August and extended into October.

Kobe had an extremely serious epidemic of typhoid and paratyphoid fever in the summer of 1945. The rate began to rise in June--the month of heaviest bombing. The peak disease rate in August was six times the average August rate of the previous four years.

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<sup>14</sup>The United States Strategic Bombing Survey: The Effects of Bombing on Health and Medical Services in Japan, Medical Division, June 1947.

The peak typhoid-paratyphoid rates for Yokohama did not correlate with bombing directly. It was, however, associated with previous bombings that damaged water mains, etc., that were still unrepaired.

An epidemic of typhoid or paratyphoid fever in Kyoto (which was not extensively bombed) may have been associated with wartime shortages relating to water-treatment devices and materials.

We have noted an increased incidence of typhoid and paratyphoid fever during the bombing period in four of the six cities covered by this study. The fact that one of these four cities was Kyoto, which was not bombed, points to the possibility of casual factors other than bombing being operative in the other three cities also. However, in spite of this possibility, conditions produced by bombing seem to be closely associated with the outbreaks in these cities.

It is noted that the incidence of enteric diseases during the bombing period in Japan is very much higher than in Germany. The combined dysentery rates for six surveyed German cities ranged from 13 to 27 cases per 100,000 persons per year and for the Japanese cities the range was 74 to 204. For typhoid and paratyphoid fever, German rates were 7 to 11 and Japanese rates were 72 to 185 cases per 100,000 persons per year. This indicates the very high incidence of these enteric diseases in Japan as compared with their place in the communicable disease picture of Germany. Dysentery epidemics with peak monthly rates such as that of Nagoya for June 1945 of 3,500 cases per 100,000 persons per year were unheard of in Germany. The peak monthly dysentery rate noted in the course of the survey of nine German cities was approximately 250 cases per 100,000 persons per year for the city of Duisburg.

Similarly the report of bombing in Germany shows no record of a typhoid fever epidemic comparable to that of Kobe in the summer of 1945 with its peak rate during August of 1,827 cases per 100,000 persons per year. Several outbreaks are reported for the nine German cities covered by the survey but none of them exceed a rate of 120 cases per 100,000 per year.

Diphtheria was quite prevalent and revealed a rapidly rising tendency in the six cities surveyed and in Japan generally. The 1945 Japanese rate was 125 cases per 100,000 persons per year. Japan had a rising rate for many years with a marked acceleration in 1943 and 1944. Association with wartime conditions, generally, is possible, but not specifically with bombing.

Meningococcus meningitis rates for the years 1941-1944 are not remarkable. 1945, however, shows consistently higher rates for several cities and for Japan generally. These rates are considerably higher than those reported in the German survey. The highest rate in Germany was 1.9 per 100,000 cases per year (Bochum, 1942) compared to 6.3 (Kyoto, 1945) for Japan. Crowding and population movements, etc., are associated with rising incidence of this disease.

. . . Japan had a low and decreasing scarlet fever rate during the period from 1941 to 1945 and there is no evidence of increase in the incidence of this disease during the bombing period. The contrast with the German experience is striking. The German rates were about ten times as high as the corresponding Japanese rates.

. . . war conditions produced increased incidence of typhus in the cities studied and in Japan as a whole, but bombing as a separate factor did not have a prominent part in bringing about the increase. Selected labor force units were responsible in a manner similar to the foreign labor force origin of typhus fever in Germany.

Of the eight diseases under observation, the only ones showing an increased case fatality rate during 1945, according to the record of Tokyo, Osaka, Kobe, Nagoyi and Kyoto, were the two children's diseases, diphtheria and scarlet fever. Ekiri also showed evidence of an increased 1945 fatality rate in three cities for which information on this disease was available. (Ekiri is a dysentery-like disease of children which exists only in Japan.)



## SECTION 4. RADIATION AND COMMUNICABLE DISEASE

### 4.1 HIROSHIMA AND NAGASAKI EXPERIENCE IMMEDIATELY FOLLOWING THE BOMBING [15]

Japan required that the following diseases be reported on a weekly basis by each city and prefecture:

1. Dysentery
2. Typhoid Fever
3. Paratyphoid Fever
4. Typhus Fever
5. Smallpox
6. Diphtheria
7. Scarlet Fever
8. Epidemic Meningitis
9. Cholera
10. Plague

The following two subsections report information from the U.S. Strategic Bombing Survey.

#### 4.1.1 Nagasaki

In the three months following the bombing of Nagasaki, no major outbreak of epidemic disease was recorded. The only significant observation was a four-fold increase in dysentery cases in October of 1945 over that of October 1944.

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<sup>15</sup>The United States Strategic Bombing Survey: The Effects of Atomic Bombs on Health and Medical Services in Hiroshima and Nagasaki, Medical Division, June 1947.

Two cases of typhoid and paratyphoid fever were reported for September and October of 1945. This compares with 14 for September and October of 1944 and 13 for the two months before the bombing.

No cases of scarlet fever or meningococcus meningitis were reported since the bombing and only 10 cases of diphtheria. Correcting for the population reduction, this still represents a decrease from earlier experience.

A few cases of smallpox developed in a neighboring village in September and a revaccination program was instituted (vaccination program had been discontinued in 1943).

Cholera, plague and typhus were not endemic in recent years and no cases were reported following the bombing.

Starting with the week of 14 October 1945, the U.S. Military Government required daily reporting on hospital cases of communicable disease. Although reporting was incomplete (and contains some duplication of cases), the data in Table 33 "bear out the belief of the U.S. Government officers that there were no serious outbreaks of communicable diseases within the city."

#### 4.1.2 Hiroshima

In Hiroshima all epidemic disease data were destroyed and none collected following the bombing. The prefectural health officer in charge of infectious diseases stated, however, that he had no information to suggest serious epidemic since the bombing.

The same health officer stated that since the bombing three months previously, he had heard of only two cases of typhoid fever, no typhus fever, and that the prevalence of diphtheria

Table 33. Hospital Cases of Communicable Diseases -  
Nagasaki

KNOWN CASES OF COMMUNCIABLE DISEASES (OLD AND NEW)	1ST WEEK	2ND WEEK	3RD WEEK
Dysentery	150	120	75
Typhoid	3	1	1
Trachoma	15	15	20
Polioomyelitis	2	2	1
Malaria	2	0	0
Pneumonia	10	6	10
Smallpox	0	0	0
Syphilis	10	20	12
Tuberculosis	79	60	50
Gonorrhea	7	11	15
Chaneroid	4	2	2
Diphtheria	0	0	0

and epidemic meningitis had not been affected by the bombing. He also stated that there had been no cholera or plague in the city for the past five years. There may have been a slight increase in diphtheria in the prefecture as four or five requests were being reviewed daily for antitoxin.

Tuberculosis was a serious health problem in both cities, but no effect on this disease was to be expected in the short interval of time that elapsed between the bombing and this survey. An increase in tuberculosis was expected to show up as time passed.

A final conclusion was expressed as follows:

How such large numbers could have fled to surrounding areas, and how the remaining population could have existed under such disrupted conditions of living without resulting epidemics is still difficult to understand, but there were no major outbreaks [Emphasis Supplied]. The gradual reoccupation has allowed sufficient time for the reestablishment of facilities for medical care and sanitation.

#### 4.2 LONG-TERM FOLLOW-UP OF HIROSHIMA AND NAGASAKI POPULATION INVOLVED IN THE ATOMIC BOMBING

The Atomic Bomb Casualty Committee (ABCC) has generated an extensive amount of statistical data which includes an attempt to relate the incidence of communicable diseases with degree of exposure to radiation.

In a review of this data [16], Anderson drew the following conclusions:

Considerable effort has been expended at ABCC, and to date, with one exception, no relationship between a variety of infectious diseases and radiation has been documented.

Hiroshima males so located (0 to 1400 meters from the hypocenter) demonstrated a significant excess of deaths due to tuberculosis, whereas Hiroshima females showed an increased frequency of deaths attributable to other (not tuberculosis) infectious or parasitic diseases. The foregoing discrepancies were particularly marked during 1951 and 1952 and appeared to disappear thereafter.

<sup>16</sup>R. E. Anderson, "The Delayed Consequences of Exposure to Ionizing Radiation," Human Pathology, Vol. 2, 1971, p. 469.

Periodic evaluations of the ABCC-JNIH Adult Health Study Population have shown no clinical radiographic or laboratory evidence of radiation related infectious disease . . . . A review of the ABCC autopsy experience in this regard also failed to document a consistent relationship between exposure status and inflammatory processes or infectious diseases.

In a study of tuberculosis and A-Bomb exposure, Kamatsu and Onishi [17] examined workers of the Mitsubishi shipyard in 1954 (and followed them). They concluded:

There was no remarkable variation in tuberculosis prevalence by distance from the hypocenter for all age groups combined. The rate in the exposed aged 30-39 was significantly higher than that in the control groups; for other age groups, rates in the exposed were smaller than in the control groups, although not significantly.

Tuberculosis prevalence in exposed persons who had acute radiation symptoms (8.6%) is higher than those without acute radiation symptoms (3.8%) . . . however, the latter rate was lower than the rate for the control groups, and the rate in the group without symptoms did not significantly exceed rates in the control groups. No interpretation of the significance of these findings is offered.

No relationship could be observed between the prognosis of tuberculosis and exposure status.

<sup>17</sup> T. Kamatsu and S. Onishi, Tuberculosis and A-Bomb Exposure, A Study of Nagasaki, Mitsubishi Shipyard Workers, Atom Bomb Casualty Commission Technical Report 15-61, 1961.

Turner and Hollingsworth [18] have reported on the incidence of tuberculosis in relation to radiation exposure at Hiroshima and Nagasaki. They concluded:

Radiation exposure was not related to prevalence or radiological extent of tuberculosis.

Although it is quite possible that an increase in tuberculosis might have been present in the irradiated survivors of the immediate post-bomb period, no such trends are noted in the follow-up of the present survivors.

#### 4.3 THE MARSHALLENSE EXPERIENCE [19-22]

Eighty-two Marshallense people were involved in exposure to radiation from fallout on the islands of Rangelap and Ailingnae. The Rangelap people received an estimated whole-body dose of 175 r of gamma radiation and the Ailingnae people received 69 r [19].

These people have been followed from the onset of the exposure, and extensive medical records are available. There is no evidence of increased incidence of communicable disease attributable to the radiation exposure. Measles, chicken pox, etc., did occur but were within the normal range.

#### 4.4 EXPERIMENTAL STUDIES

In 1954, Sheckmeister reviewed the subject of the susceptibility of irradiated animals to infection [23]. The literature he cited is quite varied with respect to (1) animals used, (2) infecting agent, (3) exposure time and intensity of radiation. He summarized his findings as follows:

In summary, the importance of infection in radiation injury is indicated by the findings that different species of animals exposed either to lethal or sublethal doses of x-radiation are much more susceptible to experimental infection, and that bacteremia produced in these animals as a result of irradiation is an important factor in radiation death . . . . It is essential that the role of post irradiation period as well as the radiation dose and challenge dose be considered. Sublethal radiation has been found to activate subclinical or latent infections in mice and possibly rats.

In 1965, Bond et al. [24] concluded that:

It is suggested that a period of increased susceptibility to inflammations and infections coincides with the first decline of the granulocytes and is overcome during the period of abortive recovery.

In 1972, A. D. Conger chaired an "Ad Hoc Panel on Research Needs for Estimating the Biological Hazards of Low Doses of Ionizing Radiations" [25]. This panel concluded that:

It is now well established that large doses of radiation (of the order of 100 rems) can cause significant impairment of the immune response, and that such effects may have far reaching and yet unpredictable implications for the well-being and physiology of the affected individual, his susceptibility to infection, for example. No such effects have been detected at doses below 20 rems.

<sup>24</sup>V. P. Bond et al., Mammalian Radiation Lethality, New York Academic Press, 1965.

<sup>25</sup>A. D. Conger (Chairman), Ad Hoc Panel on Research Needs for Estimating the Biological Hazards of Low Doses of Ionizing Radiations, UNSCEAR-A/8725, G.A. Official Records, 27th Session, Supplement #25, 1972.

Knowledge of immune processes and their response to radiation is still relatively primitive. Hence, further elucidation of this subject by appropriate investigations at higher dose levels in animals as well as human subjects is strongly indicated.

The empirical evidence from the Hiroshima, Nagasaki and Marshall Island experience is not sufficient to rule out the possibility of radiation exposure contributing to an increase in communicable disease under differing epidemiological conditions. The experimental evidence certainly suggests that there may well be a unique set of circumstances leading to considerable enhancement of communicable disease incidence following radiation exposure. More study and analysis of past data and new experimental studies are called for.



## SECTION 5. THE SPECIAL CASE OF TUBERCULOSIS

Tuberculosis is a communicable disease which differs markedly from the others under study in this report in its epidemiology and its pathogenesis. It is also the most serious of the communicable diseases when considered as a peacetime health problem. In 1971 it was responsible, in West Germany, for nearly 50 percent of the mortality due to contagious diseases. (Its contribution to total mortality in 1971, however, was only 0.6 percent [4].)

Table 34 shows the recorded cases and rates per 100,000 in West Germany for the recent years through 1971 [4]. The number of recorded cases has declined from 401,817 in 1958 to 172,093 in 1971. (The prevalence rates per 100,000 were 735.8 in 1958 and 279.8 in 1971.) The number of new cases reported annually is also shown. The prevalence figures are more important to us as they indicate the endemic base from which the rise will take place if the population is subjected to the stress of war.

The League of Nations Health Survey of Europe (1943-1944) [11] reported that there was a slight increase (reversing the downward trend demonstrable to 1939) which culminated in 1942. Even the rate for that year, however, is below the median rate observed during the 1929-1938 period.

The above report is not consistent, but not completely contradictory, with the report for Berlin, which indicated a prewar mortality rate of 82 for 1938 and a 1946 rate of 302 which represents an increase of 268 percent [26]. (N.B.: By 1946 the

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<sup>26</sup>H. H. Mitchell, The Problem of Tuberculosis in the Postattack Environment, The Rand Corporation, RM-5362-PR, June 1967.

Table 34. Prevalence and Incidence of Active Tuberculosis Cases for West Germany

YEAR END PREVALENCE			ANNUAL INCIDENCE	
YEAR	NUMBER	RATE PER 100,000 POPULATION	NUMBER	RATE PER 100,000 POPULATION
1958	401,817	735.8	--	--
1965	257,574	434.4	--	--
1966	239,990	401.4	60,019	100.6
1967	221,090	368.8	54,671	91.3
1968	211,075	349.1	51,786	85.8
1969	199,977	326.8	49,695	81.7
1970	189,122	310.1	48,262	79.5
1971	172,093	279.8	45,325	74.0

tuberculosis rate in all of Germany had doubled and returned to its prewar rate by 1948 [26].) The experience of Schleswig-Holstein in the northern part of Germany is also of interest (Table 35) as this also shows an unusually high increase based on peculiar local circumstances. The tuberculosis rate climbed from 1939 to 1943. Then with an influx of population (numbers doubled), the number of cases doubled in proportion but the death rate underwent a four-fold increase from 1944 to 1946.

Changes in tuberculosis rates are a sensitive index for overall stress changes relating to nutrition, work-load, housing, etc. Wartime conditions can be expected, therefore, to raise the incidence of tuberculosis. The length of time over which the stress is applied is important. Significant changes in tuberculosis rates are not likely to be a factor in acute short-lived stress situations.

Table 35. Number of New Cases and Deaths of Tuberculosis in Schleswig-Holstein, 1939-1946

YEAR	CASES	DEATHS
1939	1,252	407
1940	1,242	449
1941	1,516	578
1942	1,818	442
1943	2,414	637
1944	3,191	721
1945	6,034	1,332
1946	6,575	2,754

(N.B.: The change in tuberculosis epidemiology because of the continuing decrease of subclinical cases in the young may have unexpected effects on the incidence increase in stress situations. This subject is quite complex and the opinions of experts in tuberculosis control should be sought.)

## SECTION 6. COLLATERAL DAMAGE AND COMMUNICABLE DISEASE

The data and descriptions in the foregoing sections of this report do not add up to a body of knowledge enabling one to make accurate predictions on the behavior of communicable diseases in the disordered environment accompanying a tactical nuclear war in Germany. However, judgments can be made on a "best guess basis" if the war scenarios are reasonably described in terms of amount of physical damage, length of time of hostilities, behavior of the population (with regard to crowding shelter, etc.) and availability of medical and sanitation supplies, personnel and equipment. The most important factor in prediction may be summed up as "integrity of the social fabric." If the population is disciplined regarding personal hygiene and the public health and medical infrastructure functions with regard to disease surveillance and control, the epidemic disease problem should be more moderate than that encountered during World War II (given even more physical damage than occurred there). This judgment is based on the following:

1. The endemic-epidemic base has improved considerably since World War II.
2. The immunological status of the population will be improved over that of the start of World War II (especially for diphtheria and poliomyelitis).
3. Medication (essential antibiotics) is now available to treat and limit the spread of many diseases which during World War II could not be so controlled.

4. The lesson of typhus importation has been learned and is not likely to be repeated.
5. The war is likely to be much shorter than World War II, and many epidemic diseases require time to build up to maximum damage potential.

Several caveats should be added to the above assessment:

1. The response of an irradiated population combined with a concurrent epidemic might lead to unexpectedly high morbidity and mortality rates from the indicated disease.
2. The question of radiation effect on endemic disease, subclinical cases, and carrier states is certainly not settled by the limited experience recorded to date.
3. Those diseases which are proving troublesome to control during peacetime (e.g., infectious hepatitis and infectious meningitis) may cause more trouble than anticipated.
4. A change in tuberculosis epidemiology leading to higher incidence of disease should be considered a possibility. The changed experience (lack of contact with tubercle bacilli) of younger age groups today compared with the past might lead to unexpectedly high incidence and mortality rates. (This caveat is based on the possibility that a population

reaching adulthood without subclinical infection with tubercle bacilli may react in a more serious manner.)

5. And the final caveat: "Fools rush in where angels fear to tread."

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